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GROUP SIZE AND AGE-SEX COMPOSITION OF THREE MAJOR UNGULATE SPECIES IN GIR LION SANCTUARY, GUJARAT, INDIA[1]

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(*With two text-figures*)

Key words: Age-sex ratio, Gir Lion Sanctuary, grouping characteristics, management, *Axis axis, Cervus unicolor*

Grouping characteristics and population structure of chital (*Axis axis* Erxleben), sambar (*Cervus unicolor* Kerr) and nilgai (*Boselaphus tragocamelus* Pallas) were studied in Gir Lion Sanctuary, Gujarat, during 1987-89. Data on group size and age-sex composition of different species were collected during 82 monitoring of eight line transects and 153 road-strip counts conducted in summer 1987, winter 1988, winter 1989 and summer 1989. There were 492 and 3132 km of monitoring of line and road transects respectively. All three species showed positively skewed group size. Mean group size was highest for chital (6.03±5.9) and lowest for sambar (1.8±1.0). The mean group size varied significantly among seasons for chital and nilgai. The mean group size values, however, did not differ significantly between different years for all three ungulate species. The values of typical group size were significantly larger than other estimates of group size for all species. All three species showed biased sex ratios in favour of females in different seasons and years. The adult males to females ratio was lowest for chital (41:100 females) and highest for nilgai (71:100 females). The results agree broadly with findings from other wildlife areas in the Indian subcontinent.

INTRODUCTION

The pioneering work of Schaller (1967) in Kanha Tiger Reserve was the first ecological description of some of the common ungulate species found on the Indian subcontinent. Since then, there have been several studies on ungulates in this region (e.g. Eisenberg and Lockhart 1972, Berwick 1974, Sharatchandra and Gadgil 1975, Dinerstein 1980, Mishra 1982, Johnsingh 1983, Barrette 1991). Data on different population characteristics (e.g. grouping structure, densities, age-sex ratios), have contributed significantly towards a better understanding of these ungulate species.

The current level of information on various ecological aspects is, however, far from satisfactory even for the most abundant and widely distributed ungulate species in the region, i.e. chital (*Axis axis* Erxleben). Extensive research in Africa and North America (on ungulates) has, on the contrary, not only provided sound ecological data for their intensive management but has allowed some useful

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generalizations on various ecological and behavioural aspects of numerous ungulate species (e.g. Jarman 1974, McNaughton and Georgiadis 1986, Miquelle *et al.* 1992). Thus there is still a need to gather more information on all ecological aspects of south Asian ungulates to fill the gaps in the existing information as well as to strengthen the management of species and protected areas. The ungulate community of Gir Lion Sanctuary comprises of chital, sambar (*Cervus unicolor* Kerr), nilgai (*Boselaphus tragocamelus* Pallas), chowsingha (*Tetracerus quadricornis* Blainville), chinkara (*Gazella gazella* Pallas) and wild pig (*Sus scrofa* Linn.). This paper describes the grouping characteristics and population structure of chital, sambar and nilgai. Data for this study were collected under a research program initiated by the Wildlife Institute of India in 1986.

Study Area

Gir Lion Sanctuary and National Park situated in Kathiawar peninsula of Gujarat covers an area of 1412 sq. km. Gir is divided into three management units, i.e. Sanctuary West, National Park and Sanctuary East. These units differ in terms of vegetation, water availability, topography, human settlement density and, hence, degradation. Sanctuary West is relatively thickly wooded and has good water availability throughout the year. The topography is a series of undulating hills and extensive flat plain areas. National Park is densely wooded and has relatively low water availability. Sanctuary East has open vegetation and medium water availability throughout the year. Grazing by livestock of Maldharis (a pastoral community) is most intense in Sanctuary East and least in National Park. Rainfall data over the past 28 years indicates that the average rainfall in the Sanctuary West is approximately 1000 mm and it is 800 mm in Sanctuary East. Seasons are distinct. December through March is winter (average minimum temperature 9° C) followed by a hot summer (average maximum temperature 42°C), till mid June. Monsoon breaks in June and continues till September which is followed by a dry post monsoon season till mid-December.

The vegetation of Gir is tropical dry deciduous interspersed with tropical thorn forest (Champion and Seth 1968). Teak (*Tectona grandis* Linn.), forms the principal species and nearly 70% of the total area of Gir is covered with teak and its several associates. The vegetation changes along a west to east axis, from thickly wooded teak forest to open thorny *Acacia-Zizyphus* woodlands. Teak is replaced by *Anogeissus latifolia* (Roxb.), in the east.

Methods

Data collection was started in January 1987 and continued for 36 months till December 1990. Data on group size and age-sex ratios of all three ungulate species were collected during monitoring of line transects (Burnham *et al.* 1980), and road-strip counts (Hirst 1969, Berwick 1974), conducted to estimate ungulate densities (Khan *et al.* 1990). Eight line transects, each 6 km in length, and placed in stratified random fashion, were marked permanently in three units (three each in Sanctuary West and National Park and two in Sanctuary East). The line transects were monitored on seasonal basis by JAK (the first author), from December 1987 to May 1989, from 0630 hours to 0930 hours. There were 82 monitoring of line transects and each transect was, on an average, monitored twice in a season. The road-strip counts were conducted during summer of 1987, winter of 1988, winter of 1989 and summer of 1989. During each count, the existing road network of 700 km in Gir was divided into transects of almost equal lengths (average 20 km). Each road transect was monitored in morning hours and again repeated in the evening. There were 652, 679, 953 and 848 km of road transects monitored during the four counts respectively.

Group size and composition were recorded for all sightings. The animals were classified into adult male (AM), adult female (AF), yearling (YRN) and fawns (FN) following the classification adopted by Schaller (1967), Eisenberg and Lockhart (1972) and Mishra (1982). Line transect and road-strip count data were pooled for three years together and season-wise to estimate frequency distributions of group sizes, sex ratios, mean group size (MGS), median of group (MDG), median of individuals (MDD) and typical group size (TGS) following Barrette (1991). MDD and TGS are animal-centered measurements of group size reflecting the experience of average individuals in a group and are better compared to MGS and MDG which are observer-centered estimates of group size (Barrette 1991).

One way analysis of variance (ANOVA) was used to test significance of differences in MGS values for each species between seasons and years. z-test was used to test differences between overall MGS and TGS values for each species. Chi-square test was used to test differences in age-sex composition of each species between different seasons and years. All statistical tests were performed following Fowler and Cohen (1986).

Results

Grouping characteristics: Chital was the most gregarious compared to sambar and nilgai. While chital group size ranged from one to more than 50 individuals, that of sambar and nilgai ranged from one to five and one to eight respectively. All species showed positively skewed group sizes as large number of groups were seen in smaller size classes compared to bigger ones (Figs. 1 & 2). For instance, there were 15.5%, 50% and 51% groups of one individual of chital, sambar and nilgai respectively. This was, however, not the case with distribution of individuals in groups, as for example, there were 2.5%, 28% and 25% individuals in size class one for chital, sambar and nilgai respectively. These striking differences in distribution of groups and individuals in them were obvious in other size classes too which suggests that distribution of groups as well as average group size estimates based on it (e.g. MGS) may not provide realistic picture of social structure of a species since these would be influenced by extreme values or the skewed nature of the group size data. The TGS values were higher compared to MGS values and other measurements of group size (MDG & MDD). The difference between TGS and MGS were large and significant for chital (z= 336.2, P <0.01), sambar (z= 133.3, P <0.01) and nilgai (z= 76.4, P <0.01).

There was a clear pattern of seasonal variation in MGS for each species with group size being lowest

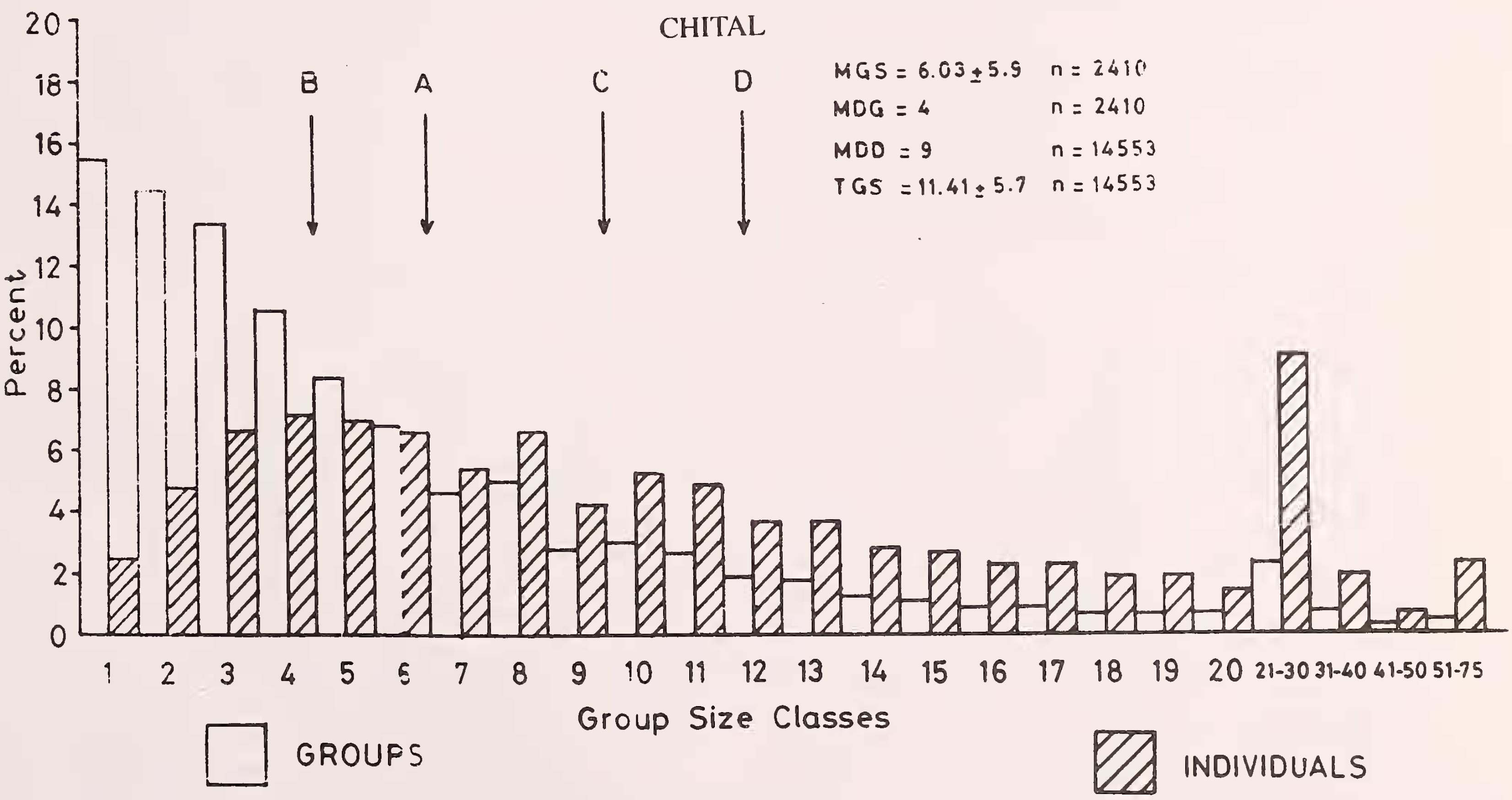

Fig. 1. Frequency distribution of groups and individuals with four descriptions of chital group size. A=Mean group size (MGS), B=Median of groups (MDG), C=Median of deer (MDD), D-Typical group size (TGS).

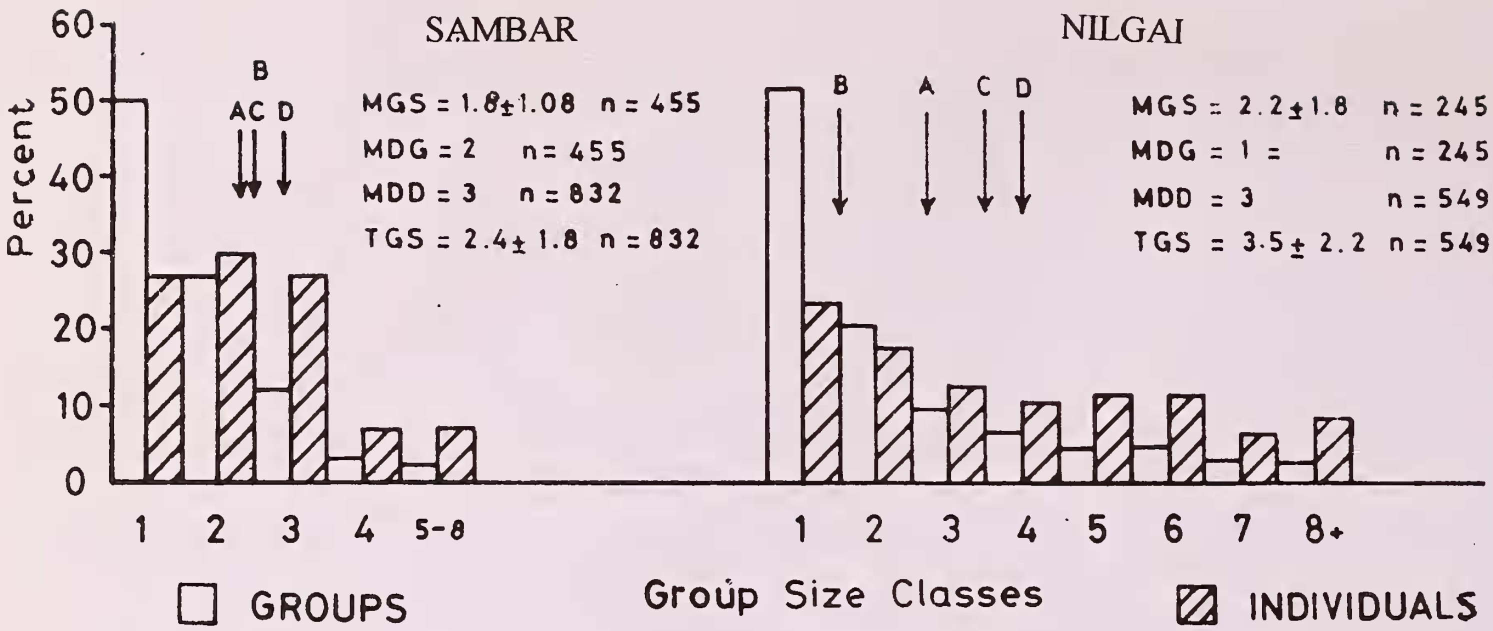

Fig. 2. Frequency distribution of groups and deer with four descriptions of sambar and nilgai group size. A=Mean group size (MGS), B=Median of groups (MDG), C=Median of deer (MDD), D=Typical group size (TGS).

during summer and highest in monsoon season (Table 1). The seasonal variation was significant for chital ($F_{3,6}$ = 48.4, P <0.05), nilgai ($F_{3,6}$ = 16, P <0.05), but not for sambar ($F_{3,6}$ = 0.076, P >0.05). However, there was no significant variation among years in MGS values for any species which suggests that MGS is a relatively stable parameter and does not fluctuate widely between different years.

Sex and age ratios: Table 2 provides the proportions of various age-sex categories of chital, sambar and nilgai in different seasons and years in Gir. The proportions of different age-sex categories of chital differed significantly among seasons (X^2=69.02, d.f. = 6, P <0.001) and years (X^2=134.2, d.f.=6, <0.001). These differences were largely associated with the changes in proportions of yearlings between seasons

Table 1

MEAN GROUP SIZE VALUES FOR MAJOR UNGULATE SPECIES DURING DIFFERENT SEASONS IN GIR

Seasons	Chital			Sambar			Nilgai		
	n	MGS	S.D.	n	MGS	S.D.	n	MGS	S.D.
Winter 1987	151	6.2	5.4	10	1.9	0.99	10	2.7	2.0
Winter 1988	627	4.4	3.7	143	1.8	1.06	95	2.4	2.1
Winter 1989	306	6.4	8.0	42	1.5	0.70	32	1.8	1.2
Summer 1987	503	5.1	4.7	103	1.7	1.02	28	2.5	1.6
Summer 1988	62	5.8	4.6	70	1.9	0.90	31	1.8	1.5
Summer 1989	505	5.9	5.8	37	1.9	1.01	19	1.8	1.2
Monsoon 1987	69	9.8	7.2	40	2.3	1.80	23	3.1	2.1
Monsoon 1988	117	8.8	15.3	35	2.2	1.90	13	3.3	2.2
Monsoon 1989	102	9.5	7.2	20	2.1	1.80	15	3.0	2.8
Post-monsoon 1987	123	5.6	4.6	14	1.7	0.97	16	2.0	1.3
Post-monsoon 1988	27	4.9	2.5	28	1.8	1.00	28	2.1	1.5
Post-monsoon 1989	65	4.3	4.0	18	1.7	1.20	8	1.9	1.1

(n=Group classified, MGS=Mean group size, S.D.=Standard deviation).

TABLE 2
PROPORTIONS OF DIFFERENT SEX-AGE CATEGORIES FOR THREE UNGULATE SPECIES IN DIFFERENT SEASONS AND YEARS

	Chital					Sambar					Nilgai				
	n	AM	AF	YRN	FN	n	AM	AF	YRN	FN	n	AM	AF	YRN	FN
Seasons															
W	4835	24.3	51.9	9.1	14.4	301	31.5	53.8	3.6	10.9	315	34.2	49.8	2.2	13.6
S	4348	20.0	54.3	12.9	12.6	386	30.0	58.5	4.9	6.4	227	41.4	43.6	3.9	11.0
M	1374	21.7	56.1	9.3	12.7	99	37.3	62.6	-	-	78	24.3	70.5	-	-
PM	805	21.7	56.6	8.8	12.7	35	28.5	65.7	-	-	9	-	-	-	-
Years															
1987	3074	21.8	55.7	7.2	15.0	231	29.8	57.1	6.0	6.9	201	39.3	44.2	2.9	13.4
1988	3610	21.7	56.1	8.0	14.0	486	29.8	60.6	2.2	7.2	333	32.4	56.1	1.2	10.2
1989	4681	22.7	50.4	14.8	11.9	104	42.3	44.2	5.7	7.6	95	40.0	41.0	6.0	12.6
Overall	11365	22.2	53.7	10.6	13.4	821	31.4	57.6	3.7	7.1	629	35.7	50.0	2.5	11.6

n-number of animals classified, AM-adult male, AF-adult female, YRN-yearling, FN-fawn, W-winter, S-summer, M-monsoon, PM-post monsoon.

TABLE 3
NUMBER OF MALES (AM), YEARLING (YRN) AND FAWNS (FN) PER 100 FEMALES FOR DIFFERENT SPECIES BETWEEN DIFFERENT YEARS IN GIR

	Chital				Sambar				Nilgai			
	n	AM	YRN	FN	n	AM	YRN	FN	n	AM	YRN	FN
Years												
1987	3074	39	13	27	231	52	11	12	201	89	7	30
1988	3610	39	14	25	486	49	4	12	333	58	2	18
1989	4681	45	28	24	104	95	13	17	95	97	15	31

n-number of animals classified.

(component X^2=9.7 & 23.01 for winter and summer) as well as years (component X^2=64.4, 9.0 & 24.8 for 1987, 1988 and 1989). The proportions of age-sex categories of sambar and nilgai were not amenable to chi-square analysis between seasons, while the same differed significantly between the years for sambar (X^2=15.7, d.f.=6, $P< 0.05$) and nilgai (X^2=58.8, d.f.=6, $P< 0.01$). The differences were largely associated with changes in proportions of males and to some extent females between years for sambar and nilgai. On the whole, the proportions of males and females were 22.2% and 53.7% for chital, 31.4% and 57.6% for sambar and 35.7% and 50% for nilgai. The proportion of animals in pre-reproductive age class (yearling and fawn) was 24% for chital, 10.8% for sambar and 14.1% for nilgai.

All three species showed biased sex ratio in favour of females during different seasons and years (Table 3). While male to female and fawn to female ratios were relatively stable for chital between seasons and years, the same showed wide variations for sambar and nilgai, possibly, due to the small sample sizes. The number of males per 100 females was 41 for chital, 54 for sambar and 71 for nilgai.

Similarly, number of fawns per 100 females was 25.8 for chital, 12.4 for sambar and 23.1 for nilgai.

Discussion

A comparison of group size and structure of chital, sambar and nilgai in Gir with data from other wildlife areas face two major limitations. Firstly published studies differ widely in their sampling methodologies and it is difficult to distinguish between real difference and differences due to sampling methods. Secondly, the choice of parameters which could be used for comparison is limited. Most of the workers have used frequency distributions of groups and mean group size for description of group structure and it is only recently that Barrette (1991), recommended the use of frequency distribution of individuals and TGS values for such a description. We have therefore used MGS values of different species only for comparison with other studies.

The overall MGS of chital in Gir is similar to values reported by Karanth and Sunquist (1992) from Nagarahole Tiger Reserve (NTR), and Mishra (1982) from Chitwan National Park (CNP), but it differs from that of Barrette (1991), and Dinerstein (1980) who reported higher MGS values for chital from Wilpattu National Park (WNP), in Sri Lanka and from Royal Karnali Bardia Reserve (RKBR), in Nepal. The MGS values of sambar and nilgai conform to the values reported by Karanth and Sunquist (1992), Mishra (1982) for sambar and Dinerstein (1980) for nilgai. It seems that the observed differences in overall MGS values between Gir and that of RKBR and WNP for chital is due to disproportionate sampling of open areas (open grasslands in RKBR and villus in WNP) as well as total sample size biased in favour of groups from open areas (e.g. 1889 groups from open area vs. 362 groups from forest in case of WNP). As groups of chital are significantly larger in open areas compared to forest (Barrette 1991), the overall MGS value would also be higher.

The overall MGS for chital was significantly higher than that of sambar and nilgai. Similar patterns have been documented by other workers also for these species. There have been attempts to explain interspecific variation in group size of antelopes in Africa (e.g. Jarman 1974) but more work is needed before one could attempt such an exercise for cervids. For instance, the sambar is expected to form bigger groups by virtue of its large body size (Mishra 1982), mixed food habits and as generalists being adapted to a wide variety of vegetation types. However, data proves it to be otherwise. While explanation can be given for smaller group size of sambar on the basis of habitat (closed forest) it occupies (structuralist explanation, Barrette 1991), its solitary nature and antipredator strategies (Johnsingh 1983), no such explanation is available for nilgai. The above explanation for sambar is quite convincing especially if one considers the group size and social organization of swamp deer (*Cervus duvauceli* Cuvier), which is similar to sambar in body size but differs in the habitat type (grassland), it occupies, food habits (grazer), and social organization (highly gregarious, overall MGS value 6.5) (Schaller 1967, Martin 1977).

The significant seasonal variation in MGS values of chital and nilgai, and lack of it in sambar has been documented elsewhere also (Eisenberg and Lockhart 1972, Berwick 1974, Dinerstein 1980, Mishra 1982, Barrette 1991). Except Berwick (1974), findings of these workers conform to the pattern of seasonal change in Gir, i.e. decrease in group size during dry season and increase in rainy season. What are the factors which cause the group size to vary in some ungulates and not in others? The social organization of species has been considered one such factor (Rodgers 1977). Group size in species which exhibit open membership social structure (e.g. chital, swamp deer), may show temporal variation not only on a seasonal basis but also during different times of the day (Sharatchandra and Gadgil 1975, Barrette 1991) whereas species having closed membership social structure (e.g. sambar), lack such variation. For species having open structure, food availability, predation risk and rutting activity (e.g. Hamilton 1971, Vine 1971, Jarman

1974, Sharatchandra and Gadgil 1975, Khan and Vohra 1992) have been considered as the main factors responsible for seasonal change. However, which one of these factors play a major role is not clear. For instance, while Sharatchandra and Gadgil (1975) attributed the increase in group size during rainy season to high food availability, Dinerstein (1980) considered predator detection as the prime reason for bigger group size due to increase in plant cover and density. We believe that an increase in plant cover and density will cause the herds to fragment not only due to purely structural reasons (Barrette 1991), but also because bigger group size will increase the probability of predation as increase in plant cover and density would benefit stalking predators such as lion.

All three ungulate species in Gir showed adult sex ratio biased in favour of females in all seasons. Others have reported sex ratios in favour of females for these species with the exception of Dinerstein (1980) for nilgai and Seidensticker (1976), for chital and sambar. They have reported sex ratios to be otherwise. These exceptions are however based on very small sample sizes and hence may not be considered representative. The disparity in adult sex ratio has been attributed to several factors such as misclassification of individuals (Sharatchandra and Gadgil 1975, Mishra 1982 for chital), higher mortality of male fawns (Schaller 1967, Johnsingh 1983 for chital), and selective predation on males (Berwick 1974 for all three species, Schaller 1967, Johnsingh 1983 for sambar, Karanth and Sunquist 1992 for chital and sambar). No attempt has been made so far to check the sex ratio at birth in the wild and for higher mortality of male fawns. Only Schaller (1967), and Johnsingh (1983) provide some data to substantiate their claims for selective predation on males in sambar. Explanations vary as to what makes males more vulnerable to either selective predation or in general higher mortality. In African bovids subsistence of subadult males on low quality forage as a result of their exclusion from established territories and harassment by dominant males have been considered as major factors for higher mortality of males (Leuthold 1977). In south Asian ungulates, solitary habits, proneness to injuries from intra-specific aggression, lack of alertness during rut and dispersal behaviour have been considered some of the factors which make males more vulnerable to selective predation (Karanth and Sunquist 1992). While Johnsingh (1983) could not find any pattern in dhole (*Cuon alpinus* Pallas) predation on chital males before and after rutting season, no objective information exists regarding influence of other factors. There is clearly a need for more work to explain such disparities with the help of more data.

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